SIBLING SET ORDER AND EDUCATIONAL ATTAINMENT: EVIDENCE FROM FULLY ADOPTED SIBLING GROUPS

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ABSTRACT. There is an extensive theoretical and empirical literature concerning the relationship between birth order and educational attainment and cognitive development. Most of these theories postulate that differences in educational attainment by birth order stem from intrafamily social dynamics, but there are also hypotheses that suggest that these differences may have biological underpinnings. This study uses Swedish administrative register data to construct full sibling data for cohorts born 1960 to 1977 for fully adopted siblings sets. Using a within-family comparison approach, I compare adopted siblings of different set order to one another to see whether set order amongst adopted children is associated with differences in educational attainment by age 30, and the likelihood of having entered tertiary education by age 30. These same within-family comparison analyses are also performed on siblings in fully biologically related sibling sets to serve as a comparison to the analyses of adopted children. I find that there is a negative relationship between set order and both educational attainment and the likelihood of entering tertiary education in fully adopted sibling sets, which is slightly stronger than that seen in fully biologically related sibling sets. These findings strongly suggest that differences in educational attainment by set order are driven by intrafamily social dynamics.

INTRODUCTION

Researchers across the social sciences have been studying the relationship between birth order and a variety of outcomes for more than a hundred years (Galton, 1874). Birth order is an important marker of early life conditions within the family, and is one that is experienced by all individuals. Previous research shows that birth order is a marker of stratification within the family, as studies show that early born children tend to have access to greater levels of resources, attention, and cognitive stimulation than later borns (Hertwig et al., 2002; Price, 2008). Evidence of the importance of this intrafamily stratification comes from research that has shown that birth order is likely to be causally related to IQ (Bjerkedal et al., 2007; Kristensen and Bjerkedal, 2007; Black et al., 2011), educational attainment (Black et al., 2005; Härkönen, 2013), and mortality in adulthood (Barclay and Kolk, 2013). Birth order is a factor that allows us to study relative deprivation as birth order effects have been observed across families with both low and high levels of educational and financial resources (Bjerkedal et al., 2007). It also allows us to isolate the effect of that relative lack of access to resources or cognitive stimulation by studying individuals within the closely shared environment of the family. Although the most widely tested theories accounting for the relationship between birth order and later life outcomes propose that this relationship is mediated by intrafamily social dynamics, some speculation remains over the extent to which birth order effects might be due to prenatal or gestational factors (Gualtieri and Hicks, 1985).

This study will use data from the Swedish administrative registers to isolate the degree to which birth order effects are prenatal or postnatal in origin through a rarely used study design, analysing the educational attainment of siblings in fully adopted sibling sets using a within-family sibling comparison approach. That is, whether the previously observed pattern of educational attainment by birth order exists amongst adopted children whose adoptive parents have no biological children of their own. In fully adopted sibling sets I will use the term set order rather than birth order to refer to the order of the siblings within the sibling group. I choose to study educational attainment as an outcome for several reasons. The amount of time spent in education remains a core influence on the development of individuals, helping to shape everything from political and religious orientation through to health behaviours, IQ, and occupational trajectories throughout the life course. As a result, educational attainment is fundamentally related to social status, health, and income development. By studying the relationship between birth order and educational attainment it is possible to get a measure of how an early life marker of stratification affects a later life outcome that is crucially related to many outcomes across the life course. For the sake of comparison I will also conduct these analyses for fully biologically related sibling sets. To foreshadow the results to be presented in more detail below, I find that the negative relationship between set order and educational attainment that has been observed in fully biologically related sibling groups persists in fully adopted sibling groups.

Birth Order and Educational Attainment: Theory and Empirical Research. There are both physiological and social theories concerning the hypothesized relationship between birth order and educational attainment. Although this study will be able to distinguish between the relative validity of biological and social theories, I will not be able to directly test the mechanisms by which it has been hypothesised birth order should be related to educational attainment within these two larger categories. Nevertheless, I will here briefly outline the various theories. A key biological theory regarding the relationship between birth order and a variety of outcomes is the immunoreactive theory (IMRT) (Gualtieri and Hicks, 1985). The IMRT explanation for the relationship between parity and a variety of outcomes is based on several principles that rest upon male antigenicity. Male antigenicity describes how histocompatability-Y antigens, exclusive to males as they are located on the Y-chromosome and thus alien to the mother, induce an immune system response from the mother when she carries a male foetus (Gualtieri and Hicks, 1985). This antibody response from the mother is hypothesised to have a permanent negative effect on the uterine environment (Gualtieri and Hicks, 1985), and would grow more severe with bearing additional sons due to the memory inherent in human immune system response (Bogaert and Skorska, 2011). The IMRT predicts a negative effect of increasing parity, but more particularly a negative effect of the number of sons, on a range of different outcomes. The IMRT has been most consistently applied to research on sexual orientation, with research suggesting that the prevalence of homosexuality amongst males is higher amongst later born boys who have a higher proportion of older brothers, which has become known as the fraternal birth order effect (Blanchard, 1997, 2001; Bogaert and Skorska, 2011). Evidence for the prenatal physiological mechanism rather than a potential alternative hypothesis regarding socialisation comes from research which shows that fraternal set order in blended and adoptive families does not have any association with homosexuality in males, while it does in fully biologically related sibling sets (Bogaert, 2006), though not all studies support the hypothesis (Bearman and Brückner, 2002; Frisch and Hviid, 2006).

Theories regarding social mechanisms for the importance of birth order on later life outcomes propose arguments involving social and economic resources concentrated within the family, and social interaction within the family. These hypotheses are the resource dilution hypothesis (Blake, 1981), and the confluence hypothesis (Zajonc and Markus, 1975; Zajonc, 1976). An additional hypothesis that is of relevance is optimal stopping theory. The resource dilution hypothesis states that as the number of children within the family increases, the portion of parental resources, including material, temporal, and interpersonal resources, available to each child decreases (Blake, 1981). Even if it is assumed that the parents will try to distribute resources completely equitably, earlier born children will have a cumulative advantage over later born children in terms of having access to resources at early ages (Hertwig et al., 2002). While later born children may have increasing access to resources at a later age when older children leave the family home, research indicates that a greater access to parental resources at early ages is more critical for success in the educational system (Campbell and Ramey, 1994). Children who receive more positive attention at home at early ages enter the education system better prepared, and this leads to cumulative advantages over subsequent grades (Campbell et al., 2001). It is also possible that parents continue to support older siblings even after they leave the home.

The confluence hypothesis argues that children must be considered as a part of their own dynamically changing environment, and that the entrance into the family of additional children reduces the aggregate level of cognitive maturity within the household (Zajonc and Markus, 1975; Zajonc, 1976). The first born child interacts exclusively with its parents, and is therefore exposed to an environment with a relatively high level of cognitive maturity. The second born, however, enters an environment where he interacts both with his parents as well as his older sibling, meaning that the average level of cognitive stimulation is lower, and this continues with any further children entering the family. Optimal stopping theory proposes that parents continue to have children until one is dissatisfactory in some way, at which point they will have no more. This would predict poorer educational attainment for the last born in sibling sets of any size. It has also been argued that the the body of results showing that later birth order is associated with negative outcomes are a methodological artefact resulting from drawing inferences about a within-family phenomenon from between-family data (Velandia et al., 1978; Page and Grandon, 1979; Rodgers, 2001). However, research that has used the highest quality data available, with full information on the siblings within a family, and conducting analyses using a within-family comparison, has found convincing support for the relationship between both birth order and educational attainment (Black et al., 2005; Kalmijn and Kraaykamp, 2005; Kantarevic and Mechoulan, 2006; Kristensen and Bjerkedal, 2010; Härkönen, 2013), and birth order and IQ (Bjerkedal et al., 2007; Black et al., 2011).

As mentioned above, most of the prominent hypotheses relating birth order to later outcomes concern the social environment that children experience within the family. A recent study concerning the relationship between birth order and IQ provided compelling evidence that the source of variation in outcomes between children of different birth orders within the same family is social rather than biological in origin (Kristensen and Bjerkedal, 2007). This study, using military conscription data from the Norwegian administrative registers, found that the IQ of second borns in families where the first child died in infancy, and the IQ of third borns where the first two children died in infancy, is equal to that of first borns in families where no infant mortality has occurred (Kristensen and Bjerkedal, 2007). Using the same study design, this

pattern was also found to pertain for educational attainment (Kristensen and Bjerkedal, 2010). However, both of these studies examining birth order in families where some of the children had died used a between-family comparison approach. A between-family analysis leaves open the possibility of confounding in the relationship between birth order and later outcomes, due to the presence of unobserved or unmeasurable intrafamily characteristics. It can be imagined that these unobserved intrafamily characteristics might be especially pronounced in families where children have died at a young age. This is particularly true in modern Norway, which has consistently had one of the lowest infant mortality rates in the world (Erickson and Bjerkedal, 1982; WHO, 2012).

Adoption in Sweden.

Adoption in Sweden. Adopting a child in Sweden is a protracted process, with potential parents having to undergo a rigorous assessment. Couples seeking to adopt are evaluated on their mental and physical health, various aspects of their personality, whether they have a supportive social network, and whether they have a strong and stable relationship (Socialstyrelsen, 2009). In addition to these evaluations, assessments are also made of the prospective parents' housing and neighbourhood, the suitability of their occupation for raising children, as well as having to meet an income threshold to be considered (Hübinette and Tigervall, 2009; Socialstyrelsen, 2009). The logic of these assessments is the explicit Swedish policy that the choice of adoptive parents should always be made in the best interests of the child, and not the prospective parents (Nordlöf, 2001). As a result of this extensive vetting procedure involved, adoptive parents both today and in the 1960s and 1970s, are older than the average biological parent, have higher levels of education, have higher incomes, and are more likely to live in urban areas (Hjern et al., 2002; Björklund et al., 2006).

Matching in the Adoption Process. A key issue to consider for this study is the extent to which matching between the biological and adoptive parents are likely to bias the model estimates. In attempting to decompose the relative importance of genetic inheritance and social upbringing, most studies that use adoption data assume that adoptees are randomly assigned to adoptive families, or ascertain that the bias invoked by partial matching is likely to be weak. In the case of non-random assignment, it would be necessary to observe and adjust for any variables that a matching procedure is based upon. More particularly, for this study it is more important that two specific aspects of this assignment process are random. The first is that it is important for this study that potential adoptive parents are not more likely to adopt a child who is a first born to his or her biological mother first, a child who is second born to his or her biological mother second, and so on. If this were the case, and there was a fundamental physiological relationship between biological birth order and later outcomes, this would imply that we could not separate biological birth order from social set order. The second specific aspect of the adoption process where it is crucial that the assignment not be biased is that the order in which children are adopted should not be systematically related to the characteristics of the biological parents. If for some reason children who are adopted first, or second, or third, to an adopted sibling group are more likely to come from biological parents of a certain social background, then this would systematically bias the estimates.

To evaluate the degree to which these assumptions are violated, it will be useful to treat domestic adoptions and transnational adoptions separately. Regarding domestic adoptees, previous research, and government documentation shows that there was a limited degree of matching (Bohman, 1970), though studies on intergenerational effects suggest that the bias is limited (Björklund et al., 2004, 2006). More specifically, the majority of adopted children were placed in either the same municipality, or a neighbouring municipality (Nordlöf, 2001), though there was also a small correlation between the socioeconomic characteristics of the biological and adoptive parents (Björklund et al., 2004, 2006). In the register data it is not possible to analyse the degree of correlation between biological birth order and adopted set order for transnational adoptees, but it is possible for a subset of the domestic adoptees. This study focuses on sibling groups of at least two children, because multiple children are needed to conduct a within-family analysis. For Swedish-born children who were adopted into a sibling group with at least two children in the cohorts under study, the correlation between birth order and adopted set order is 0.15, with a p-value of 0.00. However, the correlation between birth order and adopted set order when both sibling groups have a set size greater than one is 0.07 (p=0.00); this is important as only children always have a value of one for birth order. This weak correlation of 0.07 indicates that this is assumption has not been substantially violated. Regarding the second specific assumption, concerning a correlation between order of adoption and characteristics of the biological parents, the data for domestic adoptees show that there was a weak, but statistically significant correlation between adopted set order and the socioeconomic status of the biological mother (ρ=-0.05, p=0.03), though there was no statistically significant correlation for the biological father.

Information on matching in transnational adoptions is far more difficult to obtain. Data on the biological parents, which is often missing or incomplete even for biological parents who give their child for adoption in countries with a meticulous administrative register system such as Sweden, is even less likely to have been stored in South Korea or China, two countries from which a large portion of adoptive children in Sweden have been drawn (Hübinette and Tigervall, 2009) [see table 3]. This is particularly likely to be true given that I am studying children born in the 1960s and 1970s. Indeed, in China children have to have been officially abandoned, meaning no information is available on the biological parents, to be considered available for adoption (Chatham-Carpenter, 2012). Even under the most optimistic assumptions, it is unlikely that any such registers would also be digitised and available for public access. Furthermore, the likelihood of being able to link this data to adoptive parents in Sweden is small, and such a process would be extremely challenging. As a result, it is not possible to determine whether systematic patterns of adoption pertain for transnational adoptions for adoptive children born in the cohorts that I am studying.

Adopted Children in Sweden. A substantial volume of research has been conducted addressing how being adopted affects the outcomes of those adopted children. The effect of being adopted per se is not the focus of this paper; rather, the purpose of this analysis is to investigate whether patterns of educational attainment by sibling set order are consistent when comparing adopted children to one another. However, there are several other important factors to consider that may influence educational attainment for adopted children, which include country of origin, and age

at adoption. One reason for the importance of country of origin is that the predominant reason for giving children up for adoption may vary from country to country. For example, in South Korea, one of the most common countries of origin for children adopted in Sweden in the 1970s (Hübinette and Tigervall, 2009), children were often given up for adoption because of illegitimacy (Tahk, 1986). Similarly, Swedish women who gave up their children for adoption in the 1960s often did so because they were unmarried, felt themselves to be too young, or the pregnancy was unwanted, rather than for financial reasons (Bohman and Sigvardsson, 1990; Nordlöf, 2001). It is also very likely that the conditions in children's homes or orphanages where the child stays prior to adoption will vary in quality from one country to another, and this may be important for later development (Winick et al., 1975). There is some evidence that children given up for adoption in Sweden in the 1950s and 1960s that showed early signs of developmental problems were not considered suitable for adoption, meaning that selection processes were implemented by the government agencies (Hedberg, 1964; Bohman, 1995). Country of origin is likely to influence the degree to which adopted children are able to adapt, at the very least due to language reasons. The degree to which this might cause developmental delays for transnational adoptees is likely to depend upon the age at which they are adopted. Age at adoption is also likely to be important for other reasons. The amount of time that children were exposed to the conditions in children's homes or orphanages in the country of origin, particularly in extreme cases, could play an important role in later social, psychological, and cognitive development (Rutter, 1998). It is also possible that a later age at adoption means that the child may be less likely to form a secure attachment with the adoptive parents (Chisholm et al., 1995). Adopted children of Swedish origin were usually placed into their newly adopted families at younger ages than transnational adoptees (Dalen et al., 2008), typically before the age of 8 months (Björklund et al., 2004).

DATA, AND METHODS

Data. This study draws its information from the Swedish administrative population registers. I examine men and women from cohorts born from 1960 to 1977. The reason for using these particular cohorts is that the highest quality data on education is available from 1990 to 2007. Therefore using these cohorts allows me to look at the educational attainment of these individuals in the year that they turn 30 with a high degree of accuracy. This approach assumes that these adopted children are still living in Sweden at age 30, and the effective sample used in the analysis is slightly smaller than the numbers shown in the various tables showing descriptive information due to emigration or mortality. I will be conducting analyses on two types of families: sibling sets entirely composed of the biological children of the parents, and sibling sets that are entirely composed of adopted children. In the latter case, it is necessary that the parents have no biological children of their own for that sibling group to be included in the analysis. Of the biological children, 51% are male, and 49% are female. Of the adopted children in the study, 45% are male, and 55% are female.

As can be see in figure 1, a significant transition occurred over the years that the cohorts under analysis in this study were born in terms of the geographical origin of adopted children. In total, 42,706 children were adopted from cohorts born between 1960 and 1977. However, of these children, only 25,199 are linked to both the adoptive mother and adoptive father in the registers.

For this study it is crucial to have information on both the adoptive mother and adoptive father so as to verify that neither adoptive parent has any biological children of their own; a lack of clarity regarding whether the adoptive parents had biological children of their own would blur the ability of this analysis to clearly address the research question due to previous research showing that parents tend to preferentially invest in biologically related children over adopted children (Case et al., 2001). Of these 25,199 children who can be linked to both the adoptive mother and adoptive father, 12,132 must be excluded because at least one of the adoptive parents have biological children of their own, leaving 13,067 adopted children. Tables 1, 2, and 3 showing descriptive statistics for adopted children refer to these 13,067 children. Of these children, 401 were born in Sweden, and 12,666 were born outside of Sweden. A frequency table detailing the region of origin of adopted children during this period can be seen in table 3. As will be outlined in greater detail below, this study uses a within-family comparison approach. For a within-family comparison to be made, it is necessary that more than one child be present. This means that it is necessary to exclude from the analysis families where the parents have no biological children of their own, but have only adopted one child. It is common to adopt only one child in Sweden, and this means that 6,666 adopted children are left whose adoptive parents have no biological children of their own, and where the number of adopted children is greater than one. For the sake of clarity, I also exclude individuals in sibling groups with adopted children who share a birth date, or the same immigration data; this excludes a further 1,497 children. The meaning of birth order in adopted sibling sets with twins, or where the children were adopted at the same time, is likely to be different from that of birth order in families where there is spacing between the children. The use of the within-family comparison approach also means that only children are excluded from the analyses of biological sibling sets. Finally, for

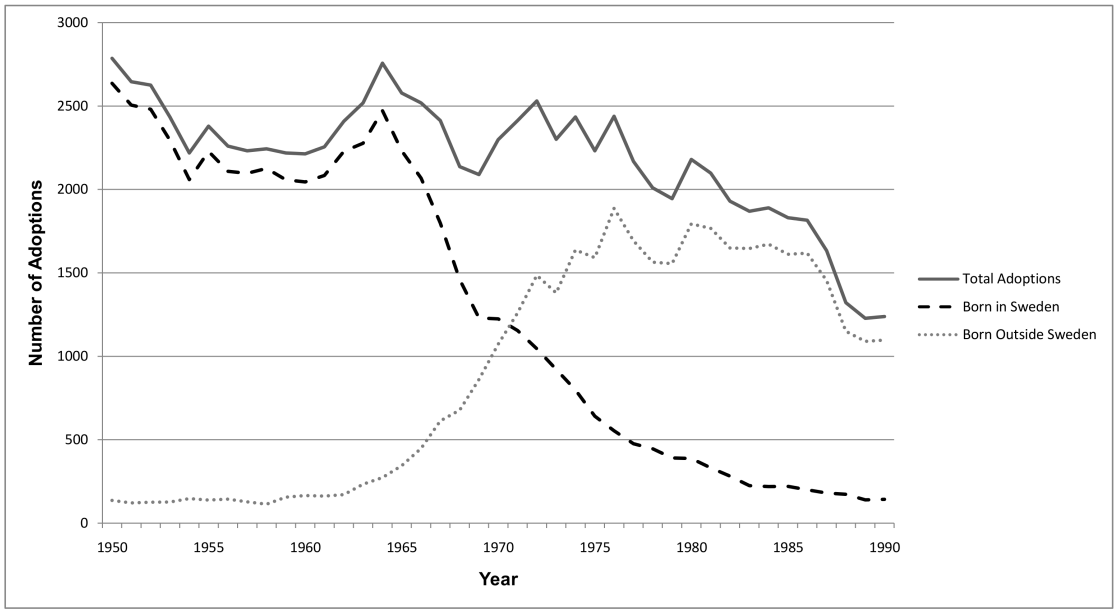

FIGURE 1. Adoption in Sweden, 1950-1990. Source: Statistics Sweden, Background Facts, Population and Welfare Statistics 2008:1, Multi-generation register 2007. A description of contents and quality.

the sake of clarity I also exclude families with adopted children who share a birth date, or the same immigration date.

Birth Order and Set Order Variables. In this study birth order in biologically related sibling sets is operationalised as the birth order to a shared biological mother and father. I exclude families that have multiple births, as the introduction of twins or other multiple birth siblings complicates the meaning of birth order in these families. In adopted sibling sets the operationalisation of set order is slightly more complicated. This is because there are two components of set order in a fully adopted sibling set, which are birth order according to birth year, and adoption order, meaning the order in which the children are adopted. In this study set order in fully adopted sibling groups is defined using both variables for birth order by birth year, and adoption order; I only include families in the analysis where the birth order by birth year and the adoption order are consistent for all the siblings in the fully adopted sibship. There are a surprising number of families who, already having adopted children, adopt an additional child where that child is older than the previously adopted child. In such families the meaning of set order is far less clear, and that is why these families are excluded. This results in the exclusion of a further 1,113 adopted children.

Covariates. When attempting to isolate the effect of birth order, it is important to take into account the cohort of the index individual, the cohort of the parents, and family size (Blake, 1989). By using a within-family comparison approach, the cohort of the parents and family size are inherently adjusted for. Because of educational expansion in Sweden in the twentieth century, the level of educational attainment has been increasing with subsequent cohorts, as can be seen in table 4. To account for this trend, I adjust for birth cohort of the index person in my analyses in single-year intervals. As described above, and illustrated in figure 1 and table 3, more than half of the children adopted in the cohorts under analysis in this study were born outside of Sweden. It is important to adjust for country of birth for several reasons, including pre-adoption conditions in the country of origin, and potential differences in post-adoption experiences in the

TABLE 1. Descriptives: Frequency of Set Size for Various Family Types for Cohorts born 1960 to 1977.

	Biological Sibships		Adopted Sibships	
Family Size	Frequency	Percentage	Frequency	Percentage
1	313,516	15.3	6,401	49.0
2	905,438	44.2	5,682	43.5
3	542,152	26.5	814	6.2
4	181,235	8.9	151	1.2
5	58,404	2.9	17	0.1
6	23,952	1.2	2	0.0
7	11,011	0.5	-	-
8	5,122	0.3	-	-
9+	5,555	0.3	-	-
Total	2,046,385	100.0	13,067	100.0

Source: Swedish administrative register data, compiled by the author.

Swedish education system for those children that are visibly non-Swedish. Statistics Sweden does not make the specific country of birth available for most countries, instead providing details on a more general region of birth. The categories used for region of birth in this study can be seen in table 3. The unadjusted means in table 3 show that there are substantial differences in educational attainment by region of birth. Adjusting for region of birth will not fully account for the various different factors that children will have experienced prior to adoption, but no further details are available that could be utilised. Therefore, I use region of birth as a crude proxy variable for pre-adoption conditions, based upon the assumption that these experiences may influence educational attainment. As discussed above, age at adoption is also an important factor to take into consideration when looking at the outcomes of adopted children. Unfortunately the specific date of adoption is not available for the cohorts under study. However, a reasonable proxy variable for transnational adoptees is to examine the date of first immigration into Sweden. While there will be some discrepancies between the actual age of adoption and date of first immigration, Statistics Sweden, the government body that administrates the data, state that age at first immigration is a reasonable substitute for age at adoption (SCB, 2011, page 19). In the analyses of biologically related siblings I therefore adjust for sex and birth cohort, while in the fully adopted sibling set analyses I adjust for sex, birth cohort, region of origin, and age at migration.

Outcome Variables. The first outcome variable used in this study is educational attainment in the calendar year of the 30th birthday of the individuals under analysis. Educational attainment

TABLE 2. Descriptives: Mean Years of Education and Proportion entering Tertiary Education by Family Size and Set Order within Various Family Types for Cohorts born 1960 to 1977. Adopted Sibships Consist of Adopted Children with Data on Both Parents and Whose Parents have No Biological Children.

		Biological Sibships		Adopted Sibships	
		Mean Years of Education	Tertiary Education	Mean Years of Education	Tertiary Education
Family Size	1	12.16	0.36	12.47	0.39
	2	12.56	0.42	12.71	0.42
	3	12.41	0.39	12.40	0.37
	4	12.03	0.33	12.67	0.45
	5	11.60	0.27	11.69	0.18
	6	11.31	0.23	-	-
	7	11.18	0.21	-	-
	8	11.14	0.20	-	-
	9+	10.92	0.19	-	-
Birth Order	Only Child	12.16	0.36	12.47	0.39
	1	12.62	0.43	12.71	0.42
	2	12.39	0.39	12.64	0.41
	3	12.13	0.34	12.24	0.33
	4	11.74	0.28	12.16	0.30
	5	11.38	0.22	-	-
	6	11.19	0.20	-	-
	7	11.07	0.18	-	-
	8	10.94	0.17	-	-

Source: Swedish administrative register data, compiled by the author.

in this study is operationalised as years of education. These years of education corresponds to the level of educational attainment, and not necessarily the actual number of years spent in schooling. The variable for highest educational level and the corresponding years of education required to reach that level come from the Swedish education registers and Statistics Sweden (Halldén, 2008; SCB, 2000). The second outcome variable is whether the individuals under analysis had entered tertiary education by age 30. Part of the reason for this second analysis is that there were substantial cohort shifts in educational attainment during the period under study. Although I will adjust for birth year in one-year categories, it is possible that this fails to fully capture the fact that later born cohorts may have greater educational attainment by age 30, and later born cohorts are also characterised by a later birth order, which would bias the estimates. However, analysing the probability of entering tertiary education by age 30 is far less likely to suffer from bias, as age 30 is an unusually late age to begin tertiary education. Education in Sweden is state funded at all levels, and tertiary education is free for Swedish and European Union citizens, though in 2011 fees for tertiary education were introduced for non-European Union citizens (Halldén, 2008; Högskoleverket, 2012). This has meant that family resources are not crucial for the transition to tertiary education in the same way that they are in other contexts, such as the United States. Approximately 33% of the Swedish population has undergone post-secondary education, which is higher than the OECD average (Högskoleverket, 2012). Students in tertiary education are eligible for financial support from the Swedish state for

TABLE 3. Descriptives: Frequency, Mean Years of Education, and Proportion entering Tertiary Education by Region of Origin and Age at Adoption for Adopted Children in Sweden with Data on Both Parents and Whose Parents have No Biological Children, born 1960 to 1977.

Variable	Category	Frequency	Percentage	Mean Years of Education	Tertiary Education
Region of Origin	Sweden	401	3.1	11.92	0.37
	Nordic	884	6.8	11.72	0.30
	Western Europe, US, Canada, Australia, and New Zealand	41	0.3	12.83	0.49
	Eastern Europe	208	1.6	12.13	0.28
	Central America and the Caribbean	1,715	13.1	12.24	0.31
	South America	535	4.1	12.66	0.44
	Sub-Saharan Africa	13	0.1	10.70	0.31
	North Africa	96	0.7	12.39	0.45
	Middle East	455	3.5	12.59	0.41
	Iran	3,859	29.5	13.16	0.52
	East Asia	1,293	9.9	12.59	0.37
	South-East Asia and Oceania	2,644	20.2	12.67	0.39
	Other Asia	923	7.1	11.52	0.22
	Total	13,067	100.0		
Age at Adoption	0-12 Months	6,362	48.7	12.99	0.46
	13-24 Months	1,942	14.9	12.63	0.41
	25-36 Months	1,091	8.3	12.58	0.42
	37-48 Months	750	5.7	12.23	0.36
	49-60 Months	553	4.2	12.03	0.31
	$>$ 61 Months	1,346	10.3	11.60	0.27
	Unknown	914	7.0	11.52	0.22
	Missing	109	0.8	11.90	0.53
	Total	13,067	100.0		

Source: Swedish administrative register data, compiled by the author.

living costs in the form of study grants and student loans with low interest rates (Högskoleverket, 2012), minimising the need for reliance on family resources for maintenance.

TABLE 4. Descriptives: Frequency, Mean Years of Education, and Proportion entering Tertiary Education by Cohort for all Children in Sweden born 1960 to 1977.

Variable	Category	Frequency	Percentage	Mean Years of Education	Tertiary Education
Cohort	1960	133,970	5.3	11.74	0.39
	1961	134,645	5.3	11.77	0.38
	1962	138,694	5.5	11.78	0.39
	1963	144,912	5.7	11.81	0.40
	1964	155,568	6.1	11.88	0.39
	1965	156,011	6.1	11.92	0.39
	1966	154,610	6.1	11.97	0.40
	1967	153,473	6.0	12.01	0.41
	1968	146,366	5.8	12.05	0.43
	1969	139,259	5.5	12.14	0.44
	1970	140,821	5.5	12.41	0.46
	1971	143,541	5.6	12.55	0.47
	1972	141,808	5.6	12.71	0.49
	1973	138,500	5.4	12.86	0.50
	1974	139,351	5.5	13.00	0.51
	1975	133,049	5.2	13.18	0.52
	1976	126,972	5.0	13.25	0.53
	1977	123,617	4.9	13.25	0.52
	Total	2,545,167	100.0		

Source: Swedish administrative register data, compiled by the author.

Statistical Analyses. The estimation strategy used for analysing educational attainment is fixed effects linear regression. By this I mean that the analysis compares the years of education attained by age 30 by siblings within the same family to one another. The estimation of the standard errors allows for correlation of errors within each sibling group. The estimation strategy for analysing the likelihood of entering tertiary education by age 30 is fixed effects logistic regression, again comparing siblings within the same family to one another. These fixed effects estimation approaches produce a within-family comparison, and inherently adjust for both observed and non-observed intrafamily characteristics that remain constant. In contrast to a between-family comparison approach, this allows for the isolation of the effect of birth order on educational attainment independent of shared family environment characteristics that are also important for educational outcomes. The within-family analyses for sibships that consist entirely of biologically related siblings compare all of these siblings to one another, as do the analyses for sibships where all of the children are adopted.

RESULTS

The results for educational attainment from the analyses on fully adopted sibling sets can be seen in table 5. Table 5 shows the results from a pooled analysis of adopted sibling sets sized from two to three, as well as separate columns for set-size specific analyses for sibling sets with two, and three children. It is not possible to look at sibling sets larger than three for these analyses. Only two families are recorded in the administrative registers as having adopted five children in the category of parents who have no biological children of their own, and when specifying that the birth order and adoption order should be consistent, the number of four child families that meet this criteria are very few. Overall there is a clearly negative gradient for the relationship between set order and educational attainment in fully adopted sibling sets. The results from the analyses where I look at the relationship between birth order and educational attainment in fully biological sibships can also be seen in table 5. Table 5 shows the results from a pooled analysis of all sibships ranging in size from two to eight, as well as analyses for specific set-sizes two to eight. As can be seen, these results show a negative relationship between birth order and educational attainment, both in the pooled analyses, as well as in the set size specific analyses. These results are fully consistent with previous studies using Norwegian register data (Black et al., 2005), as well as others using a within-family comparison approach (Kantarevic and Mechoulan, 2006; Härkönen, 2013).

Given that analyses of adopted children study families where all the children were adopted and the parents had no biological children of their own, and the analysis compares the educational attainment of adopted siblings within the same family, these results provide very strong evidence for the proposition that the way that sibling set order asserts an influence over a variety of outcomes for children is due to postnatal rather than prenatal factors. The coefficients for set order show a pattern that is very similar to that seen in the analyses for biological children, though the difference is substantially larger. These coefficients are both statistically significant and substantively significant, with set order two children obtaining more than a year less education, and set order three children attaining more than two years less education, than set order one children. I have also conducted additional analyses to verify that this pattern in educational attainment persists only when looking at families where all the children were adopted at a young age, meaning up to and including the age of 12 months. These models only include transnational adoptees, as no information on age of first migration, which has been used as a proxy for age at adoption, is available for domestic adoptees. In these models the difference from the first set order child is not statistically significant, but the sample size is considerably smaller, and the pattern of the coefficients is the same as that observed in all the other models.

TABLE 5. Within-Family Comparison Results: Analyses of the Relationship between Set Order and Educational Attainment at Age 30 from Fixed Effect Linear Regressions for Fully Biologically Related Sibling Groups, Fully Adopted Sibling Groups, and Fully Adopted Sibling Groups where All the Children were Adopted Before the Age of 12 Months.

		Set Size															
Family Type	Set Order	Pooled		2		3		4		5		6		7		8	
		β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI
Biological[a]	1	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
	2	-0.28	-0.29 , -0.26	-0.30	-0.32 , -0.29	-0.26	-0.28 , -0.24	-0.23	-0.26 , -0.20	-0.17	-0.23 , -0.11	-0.11	-0.23 , 0.00	-0.18	-0.38 , 0.01	-0.16	-0.47 , 0.15
	3	-0.40	-0.42 , -0.38			-0.46	-0.49 , -0.42	-0.38	-0.43 , -0.34	-0.27	-0.36 , -0.19	-0.16	-0.31 , -0.02	-0.14	-0.38 , 0.09	-0.44	-0.82 , -0.07
	4	-0.47	-0.50 , -0.43					-0.53	-0.61 , -0.46	-0.34	-0.46 , -0.23	-0.36	-0.54 , -0.18	-0.17	-0.45 , 0.11	-0.35	-0.81 , 0.10
	5	-0.53	-0.58 , -0.48							-0.48	-0.65 , -0.32	-0.40	-0.63 , -0.17	-0.31	-0.65 , 0.04	-0.78	-1.32 , -0.25
	6	-0.52	-0.60 , -0.45									-0.56	-0.85 , -0.27	-0.23	-0.65 , 0.19	-0.71	-1.33 , -0.09
	7	-0.55	-0.65 , -0.44											-0.31	-0.83 , 0.20	-1.09	-1.85 , -0.33
	8	-0.64	-0.82 , -0.47													-1.32	-2.23 , -0.42
	N	1,562,796		836,455		487,557		156,091		49,401		20,156		9,038		4,098	
Adopted[b]	1	0.00		0.00		0.00											
	2	-0.56	-0.86 , -0.27	-0.50	-0.82 , -0.18	-1.24	-2.11 , -0.36										
	3	-0.97	-1.78 , -0.17			-2.11	-3.68 , -0.55										
	N	4,634		4,172		462											
Early Adoptees[c]	1	0.00		0.00		0.00											
	2	-0.38	-0.85 , 0.09	-0.30	-0.81 , 0.21	-1.97	-3.18 , -0.75										
	3	-1.37	-2.80 , 0.07			-3.18	-6.13 , -0.23										
	N	2,212		2,034		178											

Source: Swedish administrative register data, compiled by the author. [a]These models adjust for sex, and cohort. [b]These models adjust for sex, cohort, region of origin, and age at adoption. [c]These models adjust for sex, cohort, region of origin, and age of first immigration to Sweden is $\leq$ 12 months; transnational adoptees only. Standard errors in all models adjusted for within-family non-independence.

TABLE 6. Within-Family Comparison Results: Analyses of the Relationship between Set Order and The Likelihood of Entering Tertiary Education by Age 30 from Fixed Effect Logistics Regressions for Fully Biologically Related Sibling Groups, Fully Adopted Sibling Groups, and Fully Adopted Sibling Groups where All the Children were Adopted Before the Age of 12 Months.

		Set Size															
Family Type	Set Order	Pooled		2		3		4		5		6		7		8	
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Biological[a]	1	1.00		1.00		1.00		1.00		1.00		1.00		1.00		1.00	
	2	0.73	0.72 , 0.74	0.71	0.69 , 0.72	0.74	0.72 , 0.76	0.79	0.75 , 0.83	0.83	0.75 , 0.92	0.80	0.67 , 0.95	0.67	0.51 , 0.88	0.88	0.57 , 1.38
	3	0.62	0.60 , 0.64			0.58	0.55 , 0.61	0.66	0.61 , 0.71	0.70	0.61 , 0.80	0.80	0.64 , 1.00	0.52	0.37 , 0.74	0.79	0.46 , 1.39
	4	0.58	0.55 , 0.61					0.56	0.50 , 0.64	0.66	0.55 , 0.80	0.62	0.46 , 0.83	0.52	0.33 , 0.80	1.15	0.59 , 2.26
	5	0.55	0.50 , 0.59							0.58	0.45 , 0.76	0.66	0.45 , 0.96	0.37	0.22 , 0.65	1.17	0.52 , 2.61
	6	0.52	0.46 , 0.59									0.59	0.36 , 0.96	0.39	0.20 , 0.78	1.38	0.53 , 3.60
	7	0.54	0.45 , 0.65											0.37	0.16 , 0.86	1.53	0.48 , 4.87
	8	0.62	0.46 , 0.84													2.19	0.55 , 8.71
	N	829,368		318,288		294,958		127,671		49,688		22,722		10,855		5,186	
Adopted[b]	1	1.00		1.00		1.00											
	2	0.63	0.44 , 0.88	0.59	0.40 , 0.87	0.53	0.19 , 1.47										
	3	0.39	0.16 , 0.97			0.27	0.04 , 1.91										
	N	1,641		1,410		231											
Early Adoptees[c]	1	1.00															
	2	0.63	0.36 , 1.09														
	3	0.14	0.02 , 0.86														
	N	666															

Source: Swedish administrative register data, compiled by the author. [a]These models adjust for sex, and cohort. [b]These models adjust for sex, cohort, region of origin, and age at adoption. [c]These models adjust for sex, cohort, region of origin, and age of first immigration to Sweden is $\leq$ 12 months; transnational adoptees only. Standard errors in all models adjusted for within-family non-independence.

Looking across the sibship size specific models for biological sibling groups, it appears that the negative effect of birth order on educational attainment decreases at any given birth order in larger sibling groups. However, this is not the case in the results from the fully adopted sibling set models. Instead, we see that the negative effect of being second is greater in sibling groups with three children than sibling groups with two children. Interestingly, the results for educational attainment from the fully adopted sibling set models overall show a decrease in educational attainment by set order that is considerably stronger than that observed in the results from the biologically related sibling groups. Indeed, a second set order child in a fully adopted sibling set has a disadvantage in educational attainment relative to the first set order child that is comparable to the eighth born child in eight child biologically related sibling groups. It can also be seen that a second set order child in a fully adopted sibling group with 2 children has a disadvantage in educational attainment is roughly equivalent to that of the last born child in fully biologically related sibling groups ranging in size from 2 to 6.

The results for the transition to tertiary education can be seen in table 6. Consistent with the results from the analyses for educational attainment, we see that there is a negative relationship between set order and the likelihood of making the transition to tertiary education for children in fully adopted sibling sets. Although the difference in the odds between set orders 2 and 3 is not statistically significant, the parameter estimates indicate that set order three children are less likely than set order two children to make the transition to tertiary education, and both set order two and set order three children are significantly less likely than set order one children to enter tertiary education. The results from the sibship-size specific models are consistent with the results from the pooled analysis. The results from the analyses where only children adopted up to the age of 12 months are included also show the same pattern, despite the small sample size. When comparing the results in tables 5 and 6, it can be seen that the sample size for studying the transition to tertiary education by the age of 30 is substantially smaller than when studying educational attainment. This is explained by the use of the within-family comparison model. If all, or none, of the children within the family made the transition to tertiary education, then there is no within-group variance for the outcome variable, meaning that it is not possible for estimates to be calculated. This also explains why it was not possible to obtain estimates for the sibship-size specific analyses where the models only include children adopted up to the age of 12 months.

Turning to the results from fully biologically related sibling sets, it can be seen that the pooled analyses in table 6 are largely consistent with the results from the models looking at educational attainment. However, the relationship is not as clear as that seen in the results for education attainment, with the parameter estimates for the likelihood of entering tertiary education rising increasing slightly again after birth order six; it should be noted, however, that after birth order three the confidence intervals for the estimates in the pooled analysis overlap one another.The results from the sibship-size specific models show that the negative relationship between birth order and the likelihood of entering tertiary education is relatively clear for sibship groups with up to five children, though the difference between later birth orders is not statistically significant. The results from sibships with eight children are not at all consistent with any of the other results discussed, but neither are they statistically significant.

DISCUSSION

By using Swedish register data, this study was able to construct data on sibling sets with multiple adopted children, which is a rare type of study design that allows this study to address the importance of social set order separately from biological birth order for educational attainment. The results for the relationship between set order and educational attainment from fully adopted sibling groups provide compelling evidence that the observed relationship obtains from social dynamics within the family, and that it is social set order rather than biological birth order that explains the widely reported birth order effect. The results from this study are consistent with findings from earlier studies using Norwegian administrative register data which also indicated that social set order was the most important factor underlying the relationship between birth order and later outcomes, such as IQ and educational attainment (Kristensen and Bjerkedal, 2007, 2010). However, this is the first study to demonstrate the importance of social set order by comparing children within the same sibling group using a within-group comparison design; previous research highlighting the importance of social set order over biological birth order has had to rely on between-family comparisons due to the nature of the study design (Kristensen and Bjerkedal, 2007). Although neither studying adopted children nor studying families where children have died in infancy results in a completely clean study design, the consistency of the results across the two designs strongly suggests that it is social set order rather than biological birth order that influences later life outcomes.

For many years adoption data has been widely used in the social sciences, including economics, sociology, and particularly psychology, to distinguish between biological and social influence on a variety of outcomes. Nevertheless, the conclusions that can be drawn from this study are not completely definitive, as data are not available to ascertain to what extent matching or systematic patterns of adoption by birth order may be biasing the results. For transnational adoptees, it is not possible to confirm that there was no process of matching between the biological and adoptive parents practiced by adoption agents. It is also impossible to say whether adoptive parents have differential preferences for children by the order in which they adopt. For example, it is possible that potential adoptive parents may be more willing to accept any child when it is their first given the long and arduous adoption procedure, but might be more selective when choosing to adopt additional children. However, despite these limitations, they are concerns that permeate the vast majority of research using adoption data. Although the degree to which there are limitations to the data is a somewhat unknown quantity, due to the unusual insight that such data allows it can be argued that the evidence that they reveal is highly useful in developing our understanding of the distinction between social and biological processes, even though one should bear in mind that there may be caveats to the conclusions that can be drawn.

Although I do not have access to data that would allow me to adjust for the characteristics of the biological mothers, the unobservable socioeconomic characteristics within the adoptive family are accounted for by this within-family comparison approach. It is also reasonable to believe that the genetic characteristics of the adopted children in this study are randomly distributed by set order. While it is certainly plausible that potential adoptive parents would be less likely to adopt a child that has genetic characteristics that manifest in a clear phenotype and that are negatively perceived, such as those causing physical abnormalities, those genetic

characteristics that are not clearly expressed in a phenotype, such as those pertaining to intelligence, are highly likely to be randomly distributed by set order within these adoptive families. If any non-random pattern in terms of the pre-adoption experiences of the child and set order may exist, this would seem most likely to manifest itself in line with the predictions of optimal stopping theory. Perhaps parents who have adopted a child who proves to be particularly troublesome may choose not to adopt any more children. However, one would imagine that most of the behaviours that would highlight themselves as being particularly egregious and separate from the general stresses of raising young children would not manifest themselves until later ages, by which time the parents may have already chosen to adopt a further child.

The results from either the educational attainment or transition to tertiary education analyses do not indicate clear support for optimal stopping theory, with a negative gradient between set order and educational attainment pertaining across the whole sibling group, but neither are the results completely inconsistent with the theory. In fact, the support for optimal stopping theory would seem to be slightly stronger in the analysis of fully adopted sibling groups, as the estimated coefficient for the last born child in the pooled analysis of fully adopted children is substantially lower than that of the younger siblings. In fully biologically related sibling groups, the last born child in all of the sibship size specific analyses, except for sibship size 7, has substantially lower educational attainment than the second last child. The results for fully biologically related sibling sets from the pooled analysis for the transition to tertiary education, however, show no support whatsoever for optimal stopping theory, though some is evident from the sibship size specific models. While this study does provide compelling evidence that it is within-family social dynamics rather than prenatal factors that mediate the relationship between set order and educational outcomes, this study has not been able to distinguish between the two most prominent postnatal theories. Research to date has struggled to distinguish between the resource dilution hypothesis and the confluence hypothesis, as these two theories offer different explanations for what is largely the same empirical pattern.

While this study compared the educational attainment of adopted children within the same sibling group to one another in fully adopt sibships where the parents have no biological children of their own, it would also have been possible to perform this analysis used sibling groups which are composed of a mix of both biological and adopted children. However, I believe that this study design would have addressed the question of social set order with less clarity, due to empirical evidence showing that parents tend to treat biological and adopted children differently (Case et al., 2001; Gibson, 2009). Even if the analyses were to exclude biological children, and only compare adopted children of different social set orders within these sibling groups, the fact that biological children tend to do better than the adopted children in these families, whether it is due to prenatal or postnatal mechanisms, means that set order within these families is likely to be less important, or operate in a different way, from fully biologically related sibling groups or fully adopted sibling groups. In a fully adopted sibling group the parents have no biological incentive to invest in one child over another, and therefore it seems more likely that social set order processes will correspond more closely to social birth order processes in these kinds of families. Although it was necessary to exclude sibling groups on a number of different criteria to perform this study, which included sibship size, plural birth status, and duplicated age at immigration, these criteria were selected so as to maximise the possibility of drawing clear conclusions from the results. While it might be argued that implementing such exclusion

criteria may limit the generalizability of these findings, the consistency with previous research strongly indicates that postnatal rather than prenatal factors play the key role in mediating the relationship between set order and educational outcomes.

ACKNOWLEDGEMENTS

I would like to thank the following people for their time and advice during the development of this study: Gunnar Andersson, Margarita Chudnovskaya, Martin Kolk, Juho Härkönen, Jens Rydgren, and participants at a lunch workshop at Stockholm University.

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